Urea Volatilisation

Aim

To determine the extent of volatilisation loss of two nitrogen fertilisers (granular urea vs. liquid UAN) applied over a number of days at the end of tillering on a Wimmera grey clay soil (Marnoo) and Mallee clay loam (Birchip).

Summary

The response to nitrogen at the Marnoo site was large (up to 0.7t/ha); whilst at Birchip the response was much smaller (0.2t/ha).

N fertiliser was applied as Urea and UAN and no differences between these two products could be ascertained.

In-crop application were timed over two weeks (four applications) to determine whether volatilisation plays a role in the availability of N following urea or UAN application. No differences according to timing could be determined.

At this stage it appears that UAN is as efficient as urea for applying nitrogen for in-crop applications.

Background

The risk and cost of applying all nitrogen requirements upfront when seasonal conditions are unknown has seen an increase in the tactical use of nitrogen in-crop through top-dressing. In many years when N fertiliser has not been required by the crop, over use of Nitrogen up front has resulted in haying off. As mentioned in previous BCG manuals, haying off is a double negative because of the direct cost of the urea not used as well as the reduced yields and quality due to a poor finish to the season.

While top-dressing in-crop seems to be the logical answer, we know it is not straight forward. One of the problems associated with top-dressing granular urea is that it volatilises when applied to highly alkaline soils if it does not rain sufficiently to wash the product into the soil.

Volatilisation is the loss of ammonia to the atmosphere. A light rain (1mm) or heavy dew will increase the chance of volatilisation as the moisture will dissolve the urea granules without moving it into the soil. It is thought that a rainfall even of greater than 5mm (on light soils) and 8mm (on heavier clay soils) is required to get movement into the soil and rooting zone. Last year BCG quoted some work carried out by CSIRO that showed that on our soil types with a pH above 8.0, 35% of N applied as urea can be lost if it does not rain within 8 days of application.

Consequently a better way needs to be found to apply N fertiliser during the season. If there is to be an alternative to using urea it has to be more reliable in relation to uptake (i.e, higher N efficiency) and it has to be cheap and convenient.

UAN (Urea Ammonium Nitrate) is a liquid formulation of nitrogen which may be an option to reduce volatilisation. The N in UAN applied in crop is at least partially taken up through the leaves and the AN component (Ammonium Nitrate) is more stable and is less likely to volatilise; the U component (Urea) will still have the same potential to volatilise as granular urea.

Methods

Trial site: Birchip and Marnoo

Replicates: 4

Plot Size: 3m x 25m

Variety: Yitpi

Sowing Date: 25th June (Birchip), 3rd June (Marnoo)

Seeding Density: 175pl/m^2

Fertiliser: Granulock 10Z at 50kg/ha

Herbicides: TriflurX 0.8L/ha IBS

Atlantis 0.3L/ha + Hasten 1% Early Post Emergence

MCPA500 0.35L/ha + Lontrel 0.1L/ha Late Post Emergence

The N product and timing of applications are described in Table 1.

Table 1: N product and timing of application treatments at Birchip and Marnoo

N product	Timing*	Rate^ (Urea kg/ha) (UAN L/ha)		Timing#
		Birchip	***Marnoo***	
Control	No N	0N	0N	
Urea	IBS	60	100	Pre-sowing
UAN	IBS	65	90	Pre-sowing
Urea	Top-dressed	60	100	GS30
Urea	Top-dressed	60	100	GS30 + 4 days
Urea	Top-dressed	60	100	GS30 + 8 days
Urea	Top-dressed	60	100	GS30 + 12 days
UAN	Foliar applied	65	108	GS30
UAN	Foliar applied	65	108	GS30 + 4 days
UAN	Foliar applied	65	108	GS30 + 8 days
UAN	Foliar applied	65	108	GS30 + 12 days

* IBS = Incorporated at sowing; Top-dressed = spread in crop; Foliar applied = sprayed using flat fan nozzles in crop.

GS 30 = end of tillering

^ the Urea and UAN rates were equivalent in kg of N applied

Results

Rainfall

Rainfall events and amounts during the time of the N application at GS30 (end of tillering) are listed in Table 2 and 3. Included in the tables are the dates that N was applied (shaded columns).

Table 2: Birchip rainfall during the topdressing and foliar application period. The shaded columns are the dates that N was applied in-crop.

	2/9	5/9	8/9	9/9	16/9	17/9	19/9	22/9	29/9	7/10
mm		1		3		5.5	5		11	9

Table 3: Marnoo rainfall during the topdressing and foliar application period. The shaded columns are the dates that N was applied in-crop.

	29/8	30/8	1/9	2/9	6/9	7/9	10/9	14/9	17/9	19/9
mm		14	1		3		3		6.5	6

Yield

Nitrogen response

At both the Birchip and Marnoo sites, the control (no nitrogen), was significantly lower in yield compared to nitrogen treatments. At Birchip the control yielded 2.1t/ha (N treatments on average 2.3 t/ha); at Marnoo the control yielded 3.6t/ha (N treatments on average 4.3 t/ha).

There were no differences between the two products used. The yield responses were the same whether Urea or UAN was used.

N timing in relation to volatilisation

There were no differences at either Birchip or Marnoo, in yield when comparing Urea with UAN in relation to the timing of the product (Table 4).

Table 4: Yield (t/ha) for the Birchip and Marnoo site for the nitrogen treated plots

	Birchip (t/ha)		**Marnoo (t/ha)**	
N timing	**Urea**	**UAN**	**Urea**	**UAN**
Pre-drilled	2.3	2.2	4.1	4.1
GS30	2.4	2.5	4.2	4.1
GS30 + 4 days	2.3	2.1	4.3	4.4
GS30 + 8 days	2.3	2.2	4.5	4.1
GS30 + 12 days	2.3	2.2	4.2	4.2
Significant difference:	**NS**		**NS**	
CV%	**4.0**		**5.3**	

Protein

At Birchip there was no difference in protein between the control (14.9%) and those plots treated with nitrogen (15.2%).

At the Marnoo site, protein was significantly lower in the control (9.5%) than for those plots with nitrogen applied (10.5 to 11.5%) (Table 5). Protein levels were significantly lower in the UAN treated plots when compared to those plots treated with Urea (Table 5).

Table 5: Protein (%) for the Birchip and Marnoo sites for the nitrogen treated plots

	Birchip		**Marnoo**	
N timing	**Urea**	**UAN**	**Urea**	**UAN**
Pre-drilled	15.0	15.2	10.7	10.0
GS30	15.2	15.0	11.5	10.5
GS30+4 days	15.5	15.2	11.1	10.7
GS30+8 days	15.1	15.1	11.7	10.5
GS30+12 days	15.3	15.6	12.1	10.5
Significant Difference:	**NS**		**P<0.05**	
LSD 0.05			**0.7**	
CV%	**2.0**		**3.1**	

For both the Birchip and Marnoo sites there were no differences in screenings between the control and nitrogen application nor nitrogen timing. At Birchip the screenings ranged from 5.2% to 6.2%. At Marnoo the screenings ranged from 1.5% to 2.4%.

Interpretation

The results for Birchip are difficult to interpret because the nitrogen responses at this site were so low. The site was high in soil N at sowing and it would have been only in a season with a higher yield potential that we may have observed differences between treatments.

For the Marnoo site, a substantial rainfall event fell the day after the first in-crop application (14mm on August 30); and the last application timing (date applied: September 14: rainfall 7mm on September 17 and 6mm on September 19). For the application timing in the middle of these two the rainfall events were small – only 3mm.

There were no differences in yield response between the two application timings with good follow up rain as compared to the two application timings with little follow up rain. We can only conclude that with the rainfall events which occurred this year that both Urea and UAN are equally effective in getting into the plant – there is no evidence that the urea volatilised and was not available to the crop.

At Marnoo, the grain protein content for the urea treatments was higher than for the UAN treatments for most of the application timings (not the second in-crop application, GS30 + 4 days). This is an usual result considering that there was no difference in yields and that it did not apply to all in-crop timings – we need to investigate this effect further in this coming season.

Note on Green Urea trial

Green Urea was also trialed at the Birchip site in 2005. Green urea contains 46% nitrogen and incorporates a urease inhibitor (Agrotain). The advantage of Green Urea is that the granule is supposed to be protected from volatilisation for the first 14 days after application. This gives it a wider window for application timing and the potential to reduce volatilisation on most soil types. In 2005 there was no difference in the yields from Green Urea and urea.

Commercial Practice

This trial does not prove that nitrogen uptake from urea is more or less efficient compared to UAN. There were no differences in yield between the two products or application timings, and the protein results were not clear.

At this stage using the information from these two trials, applying granular urea into a standing crop at the end of tillering was as efficient for nitrogen uptake as spraying UAN onto the crop. It is possible that the thick canopy at the end of tillering protects the granular urea from volatilisation until the next rainfall event.